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Task Dynamics & the (Ecological) Information They Create

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Embodied cognition is the hypothesis that behavior is not simply caused by the brain. Instead, behavior emerges from the interactions between brains in particular kinds of bodies embedded in environments that provide certain kinds of opportunities for activity. Theories of embodied cognition require a mechanism to support how these distributed resources can remain in contact with one another so that they can be assembled into task-specific solutions to problems. These theories of embodied cognition, especially the non-representational kinds, typically rely on James J. Gibson's (1979) notion of *ecological information* as the relevant mechanism, and there is extensive empirical support for the claim that this information both exists and is used by organisms to coordinate and control their activity.

For Gibson, information refers to structures in ambient energy arrays (e.g. light for vision) that are specific to the object or event in the world that caused the structure. This structure becomes information when we use it to coordinate and control our behavior, and this information supports what Gibson (1979) referred to as the *direct perception* of our environments.

This account of how we maintain psychological contact with the world has been formalized in the years since Gibson's death in the context of *task dynamics* (e.g. Saltzman & Kelso, 1987). Objects and events in the world can only be identified uniquely at the level of dynamics (the description of how a system changes over time, with reference to the forces causing the change; Bingham, 1995). Some of these dynamics can then be mapped into energy arrays as kinematic patterns (descriptions of change with no reference to underlying forces). These kinematic patterns, although not identical to the dynamical objects or events, can be specific to them (Runeson & Frykholm, 1983; Turvey, Shaw, Reed & Mace, 1981) and therefore be informative about them. Detecting a specifying kinematic pattern is equivalent to perceiving the underlying dynamic, and our perceptual systems are exquisitely sensitive to these patterns.

A given task dynamic can, by definition, only produce information about that particular dynamic. Information-based control of behavior is therefore task-specific, and so empirical research that investigates information-based explanations for behavior therefore follows four crucial steps (Wilson & Golonka, 2013; see there for specific research examples):

1. Identifying the task facing the organism at the level of task dynamics
2. Use this task dynamical analysis to identify a comprehensive list of the specific resources offered by the task to support a solution, in particular the task-specific information variables created by the task dynamics
3. Describe how these resources are assembled into a solution to the task at hand (generally a dynamical model built only from the resources identified in [2])
4. Test the model and it's predictions in real organisms

The purpose of this presentation is to introduce this ecological, biological notion of information and the related research programme to the artificial life community, where 'information' typically refers to measures of entropy, following Shannon. An information theoretic analysis may prove useful to our scientific understanding of ecological information but regardless, that is not the kind of information biological systems interact with as they perceive and act in their environments. That is Gibson's information. Understanding this ecological information is a critical part of understanding how biological life gets up to the things that it does. It may also, therefore, be of use to helping artificial life get up to those same things.

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